

U. S. ARMY ENGINEER DIVISION, NEW ENGLAND  
CORPS OF ENGINEERS424 TRAPELO ROAD  
WALTHAM 54. MASS.ADDRESS REPLY TO:  
DIVISION ENGINEER

REFER TO FILE NO.

NEDGW

20 March 1963

SUBJECT: Reconnaissance Report, Beaver Brook, Keene, New Hampshire

TO: Chief of Engineers  
ATTN: ENGCW-P  
Department of the Army  
Washington 25, D. C.

## 1. AUTHORIZATION

This report is submitted pursuant to authority contained in Section 205 of the Flood Control Act, approved 30 June 1948, as amended by Section 205 of Public Law 87-874, 87th Congress, adopted 23 October 1962 and in accordance with ER 1165-2-102 dated 15 June 1960.

## 2. REVIEW REPORT

Under the authority contained in the resolution of the Senate Committee on Public Works adopted October 3, 1960, studies of Survey Report scope of the Beaver Brook flood control problem have been conducted. Under Section 205 of the Flood Control Act of 1948 as amended in 1962 by Section 205 of Public Law 87-874, Congress increased the limit of Federal costs of small flood control projects to \$1,000,000. The proposed Beaver Brook project is well within this limitation and authorization can be expedited by the Chief of Engineers under this authority without specific approval by Congress. A negative report is therefore being submitted under the former authority (resolution of October 3, 1960), in order that further work on the project may be carried out under the small project authority provided by Section 205 of the Flood Control Act of 1948 as amended.

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### 3. SCOPE OF STUDIES

a. General Information. - Preliminary studies and investigations made in connection with the Survey Report studies of the Beaver Brook site authorized by the Senate Committee on Public Works resolution dated October 3, 1960 indicate economic feasibility of providing a local protection project at this site.

b. Topographic Surveys. - A topographic survey of the proposed project area on a scale of 1" = 50' and a contour interval of 2 feet was made in January 1962.

c. Geologic and Subsurface Information. - Geological reconnaissance of the proposed project area has been made. Subsurface explorations were performed during March and April 1962, and consisted of 5 borings and several test pits and trenches.

d. Economic Investigations. - A detailed damage survey was made after the April 1960 flood. The survey covered damages to industrial, commercial and residential properties, as well as utilities. Physical damages were evaluated, and also non-physical damages such as loss of wages, production and profits, and the use of temporary quarters and equipment.

e. Office Studies. - Office studies consisted of comparison of alternate dam sites; hydrologic and hydraulic analyses; comparisons of alternative designs and heights of embankment; preparation of designs and plans; and determination of approximate quantities and costs of the major items of construction, roadway and utility relocation, and real estate required for the project.

f. Field Reconnaissance. - Field reconnaissance and inspections of the problem area and sites of potential development have been made by representatives of the Division Engineer.

### 4. PRIOR REPORTS

There have been no previous reports by the Corps of Engineers on flood control measures for Beaver Brook. A plan of channel improvement was prepared by the New Hampshire Water Resources Board and submitted to the City Government in 1941,

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but was not adopted. Camp, Dresser and McKee, consultants to the City of Keene, have completed a report on storm drainage control in the Beaver Brook flood plain. They have also conducted an investigation of alternative sources of water supply for Keene.

## 5. DESCRIPTION OF AREA

The site of the proposed local protection project is shown on the inclosed vicinity map, (See Incl. 1). Beaver Brook, with a drainage area of about 10 square miles, is a small tributary of the Ashuelot River, which is in turn a part of the Connecticut River Basin. The brook flows into and through Keene, New Hampshire and joins another tributary called the Branch, which then discharges within a few hundred feet into the Ashuelot River. Beaver Brook drains parts of Keene and Gilsum and a small part of Sullivan, New Hampshire. The headwaters rise at elevations up to nearly 1600 feet above mean sea level. The valley floor in the reservoir area (above the Route 9 crossing of the brook) slopes from elevation 880 at the upper or north end to elevation 775 at the southern end. The brook then drops more rapidly to the flood plain in Keene, through which it flows for about two miles before joining the Branch and the Ashuelot River at an elevation of about 460 feet above mean sea level.

## 6. FLOODS

The City of Keene has been susceptible to heavy flood damages throughout its history, and has had seven major floods in recent years. The November 1927 flood resulted from rainfall of 4 to 5 inches falling on saturated ground. The April 1934 flood was the result of heavy rains combined with heavy snowmelt, causing two major rises in river stages only six days apart. The largest flood of record occurred when the hurricane of September 1938 passed over the watershed. Rainfall accompanying this storm, combined with precipitation of the previous three days, totalled more than 10 inches. The November 1950 flood was a result of 3 to 4 inches of intense rainfall on previously wet ground. The October 1959 flood produced substantial peaks in the Branch and the South Branch rivers, which was a result of about 4 inches of rain in 24 hours. The April 1960 flood occurred when 3 to 4 inches of rain fell on snow with a high water content.

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With a high degree of control of the Ashuelot River provided by Surry Mountain and Otter Brook Dams, flood stages in the Ashuelot will be less critical than in the past. High runoff from Beaver Brook, during periods of abnormal precipitation or snowmelt, continues to produce floods within the city limits of Keene.

## 7. FLOOD DAMAGES

The flood of April 1960 caused damages estimated at \$100,000 in Keene, from high water in Beaver Brook. Eleven industrial firms, seven commercial establishments and about 250 residences housing approximately 400 families were affected by flooding of grounds and cellars. The estimated damages do not include municipal costs such as cleaning up debris in the flooded area, or providing emergency facilities. It is estimated that a recurrence of 1938 flood stages in the Ashuelot River Basin would cause losses of \$2,970,000 along Beaver Brook.

## 8. PLAN OF IMPROVEMENT

a. General Description. - The flood protection plan for Beaver Brook would consist of a flood control dam about 1,100 feet upstream from the Route 9 crossing of the brook. The dam, with a top elevation of 825 feet mean sea level, would be of rolled earth fill with rock slope protection, approximately 990 feet long and with a maximum height of 52 feet above the stream bed. The top would be 20 feet wide. A chute-type spillway, with a concrete ogee weir 55 feet in length and with its crest at elevation 810 mean sea level would be located on the right abutment. Local interests have requested that the features incorporated in the dam include minimum provisions for future raising, since there is a strong possibility that water supply storage will be needed at a later date (See Incl. 2, Resolution of Keene City Council). Minimum provisions for future raising consist of increased strength of conduit to allow for future embankment loading, increased size of conduit to allow for installation of water supply discharge line, increased length of conduit such that the dam may be raised approximately eight feet without relocation of the outlet structure, and provision of a flood control outlet (with temporary plug) through the concrete spillway weir. In addition, the City of Keene has indicated that land acquisition and relocations would be accomplished initially to provide for the multi-purpose use.

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b. Discussion. - The proposed plan (See Incl. 3) would furnish the desired protection against flooding of Beaver Brook, with its associated damages to residential, commercial and industrial properties, its dangers to health and sanitation and its burden of extra municipal costs. The inclusion of minimum provisions for future raising, at non-Federal expense, would enable later expansion of reservoir facilities for water supply.

c. Estimate of Cost and Annual Charges. - Preliminary estimates of Federal and non-Federal first costs and annual charges are given in Tables 1 and 2. The annual charges are based on a 100-year project life, with 2.875 percent interest rates for both Federal and non-Federal charges. Interest during construction is omitted from the investment costs since the construction period is less than two years. The New Hampshire Department of Public Works and Highways had already programmed reconstruction of Route 10 in the reservoir area, but tabled the plans pending the flood control studies of Beaver Brook. Estimated costs of highway relocation are based upon the difference in cost between relocation as originally planned, and as revised in accordance with plans for Beaver Brook Dam and Reservoir for flood control use. Costs of extra lands and relocations are based upon provisions for additional requirements for future multi-purpose use, at the discretion of local interests.

TABLE I

FIRST COSTBEAVER BROOK DAM  
(1962 Price Level)

<u>Item</u>	<u>Estimated Quantity</u>	<u>Unit</u>	<u>Unit Price</u>	<u>Amount</u>	<u>Total</u>
LANDS, DAMAGES AND RELOCATIONS					
Lands to Elev. 820 msl		L.S.		\$140,000	
Extra lands to Elev. 828		L.S.		40,000	
Relocations, Roads		L.S.		110,000	
Extra road relocation costs		L.S.		66,000	
Relocations, Utilities		L.S.		50,000	
TOTAL					\$ 406,000
RESERVOIR CLEARING	10	Acre	500		5,000
DAM					
Preparation of Site	7	Acre	600	\$ 4,200	
Stream Control		L.S.		1,500	
Earth Exc., common	91,000	C.Y.	0.60	54,600	
Rock Excavation	10,000	C.Y.	4.00	40,000	
Impervious Borrow	26,000	C.Y.	0.60	15,600	
Impervious Fill (placing)	24,800	C.Y.	0.25	6,200	
Pervious Fill (in place)	10,600	C.Y.	1.00	10,600	
Random Fill (placing)	30,000	C.Y.	0.20	6,000	
Gravel Bedding (in place)	9,000	C.Y.	2.00	18,000	
Rock Borrow	3,000	C.Y.	4.20	12,600	
Rock Fill (placing)	12,000	C.Y.	1.00	12,000	
Concrete	2,500	C.Y.	35.00	87,500	
Conduit, complete		L.S.		36,000	
Miscellaneous items		L.S.		30,500	
Sub-Total				335,300	
Contingencies				67,700	
TOTAL					403,000
ACCESS ROAD					28,000
MISC. EQUIPMENT					24,000
BUILDINGS, GROUNDS & UTILITIES					10,000
TOTAL DIRECT COSTS					876,000
INDIRECT COSTS					
Engineering and Design				105,000	
Supervision and Administration				45,000	
TOTAL INDIRECT COSTS					150,000
TOTAL PROJECT FIRST COST					\$1,026,000

TABLE 2  
ALLOCATIONS OF COST

	<u>Federal</u>	<u>Non-Federal</u>	<u>Total</u>
<b>FIRST COSTS</b>			
Lands, damages & relocations	\$ -	\$300,000	\$ 300,000
Extra lands, damages & relocations	-	106,000	106,000
Dam	595,000	-	595,000
Minimum provisions for future raising	<u>-</u>	<u>25,000</u>	<u>25,000</u>
<b>TOTAL FIRST COSTS</b>	<b>\$595,000</b>	<b>\$431,000</b>	<b>\$1,026,000</b>

(Note: Investment costs are the same as construction costs,  
since the construction period is less than two years).

**ANNUAL CHARGES**

Interest	\$ 17,100	\$ 8,630	\$ 25,730
Amortization	1,070	540	1,610
Maintenance & Operation	-	3,000	3,000
Major Replacements	-	450	450
Ec. adjust. for net loss of productivity of land	<u>-</u>	<u>-</u>	<u>-</u>
<b>TOTAL ANNUAL CHARGES</b>	<b>\$ 18,170</b>	<b>\$ 12,620</b>	<b>\$ 30,790</b>

**9. BENEFIT-COST RATIO**

The estimates of benefits and annual charges for flood control are \$84,500 and \$30,790 respectively. The benefit-cost ratio is 2.6 to 1.0. No benefits or annual charges have been included for extra lands, damages, relocations and construction to provide for future raising as these costs are allocable to future water supply.

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## 10. ALTERNATIVE PLANS

Alternative solutions to the flood problem other than a flood control dam were found impractical and unjustified. Alternative arrangements for the flood control dam, for which plans and estimates were also prepared, were as follows:

a. Dam for Flood Control Only. - In view of the probability that the City of Keene will need additional water supply storage from Beaver Brook Reservoir at a later date, it is not considered practicable to construct a flood control dam without including minimum provisions for future raising for multi-purpose use.

b. Multi-Purpose Dam. - Because of recently discovered wells that may supply Keene's additional water supply needs for a decade or more, the City of Keene does not wish to pay the additional cost of including water supply storage in the reservoir at this time, although it is planned to secure the lands and relocations on the basis of future multi-purpose use of the reservoir.

## 11. LOCAL COOPERATION

There is a strong desire for a solution to the flood problem on Beaver Brook in Keene, New Hampshire. The City Council has requested the Corps of Engineers to study the problem, has cooperated with representatives of the Corps in furnishing information and arranging for meetings with local interests, and has furnished preliminary assurances of local cooperation, (See Incl. 2, Resolution of Keene City Council).

A public hearing was held on 7 February 1962 in Keene. Various individuals and representatives of local, municipal and state interests expressed their support for a flood control dam on Beaver Brook or emphasized the need for flood protection and drainage improvements without specifying the methods to be used. They cited damages, inconveniences and health hazards from flooding, as well as emergency costs and depreciation of property values. No one spoke in opposition to the project. The public hearing indicated a unanimity of opinion regarding the need for a flood control project on Beaver Brook.



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## 12. INDICATED INTERAGENCY COORDINATION

Liaison has already been accomplished, up to but not including a formal review of plans, for a study of Survey Report scope of the flood control and related problems on Beaver Brook.

## 13. ESTIMATED COSTS FOR PREPARATION OF DETAILED PROJECT REPORT

Following is a cost breakdown for the estimated funds required for the preparation of a Detailed Project Report for Beaver Brook in Keene, New Hampshire. A large part of the work has already been done in the preparation of the draft of the Survey Report, before eligibility for PL 87-874 was indicated, but additional funds are required. Estimated costs of preparation of a Detailed Project Report are as follows:

<u>Uniform Cost Classification</u>	<u>Feature</u>	<u>Current Cost Estimate</u>
30.1	Prelim. Planning & Public Contacts	\$ 1,000
.2	Surveying and Mapping	5,000
.3	Materials and Foundations Invest.	35,000
.4	Real Estate Studies	500
.5	Hydrology and Hydraulics	3,000
.6	Design and Drafting	38,000
.7	Reproduction	500
.8	Specifications and Estimates	15,000
.9	Special Studies	2,000
.10	Engineering During Construction	5,000
	TOTAL	\$105,000

Preauthorization survey report funds in the amount of \$40,000, approved by OCE 1st Indorsement of 5 July 1962 to NEED letter of 26 June 1962, have been expended. The tentative project schedule calls for preparation of a Detailed Project Report by 30 June 1964.

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14. RECOMMENDATION

It is recommended that preparation of a Detailed Project Report for a local protection flood control dam and reservoir on Beaver Brook in Keene, New Hampshire be authorized at an estimated cost of \$105,000.

3 Incl

1. Vicinity Map
2. Resolution
3. Plan

P. C. HYZER

Colonel, Corps of Engineers  
Division Engineer

cc: Mr. Leslie  
Col. Hyzer  
Mr. Hill  
Mr. Hicks  
Eng. Div. File



# CITY OF KEENE

IN THE YEAR OF OUR LORD ONE THOUSAND NINE HUNDRED Sixty-Three

## A RESOLUTION Relating To: Beaver Brook Flood Control Dam

Resolved by the City Council of the City of Keene, as follows:

That the Corps of Engineers be requested to approve the construction of a dam initially for flood control, but with minimum provisions for future raising, and

That all lands, easements, and rights-of-way necessary for project construction be provided without cost to the United States, and


That the United States be held and saved free from damages due to the construction works, and

That the project, after completion, be maintained and operated in accordance with the regulations prescribed by the Secretary of the Army, and

That assumption of full responsibility for all project costs in excess of the Federal Cost Limitation of \$1,000,000.00 found necessary to provide a complete project be provided by the City subject to approval of said amount by the City Council, and

That the City make cash contributions for project costs allocated to project features other than flood control, and

Should the request be granted by the Corps of Engineers, that the final project agreement forms be submitted to the City Council of the City of Keene for its consideration.

  
\_\_\_\_\_  
Mayor

PASSED February 21 1963

A true copy

Attest:

  
City Clerk, Keene New Hampshire

INCLOSURE 2B